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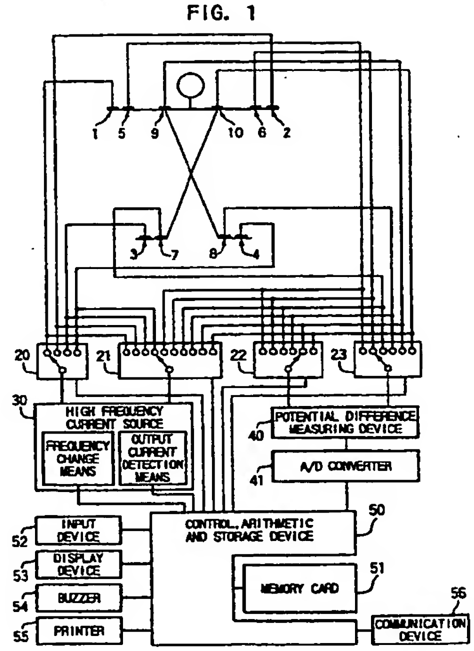
(54) LIVING BODY IMPEDANCE MEASURING INSTRUMENT AND BODY COMPOSITION MEASURING INSTRUMENT

(57) High frequency current application electrodes are brought into contact with both hands, both feet, etc., which are extreme parts of a body in order to apply current to the parts of the body to be measured. Potential difference measuring electrodes are brought into contact with the parts to be measured along the path of the high frequency current. High frequency current application electrodes and potential difference measuring electrodes are selected to select the path of the high frequency current and the path of the potential difference measurement in accordance with the purpose. Impedance on each of the parts of the body is measured and body composition is derived.

FIG. 1



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Description

Background of the Invention:

Field of the Invention:

[0001] The present invention relates to a living body impedance measuring instrument, and a body composition measuring instrument for producing a body composition in a whole body or in a part of a body of a person to be tested, based upon the living body impedance measured.

Description of the Prior Art:

[0002] It is well known to predict a body composition using a living body impedance (see, for example, "Assessment of fat-free mass using bio-electrical impedance measurement of the human body", The American Journal of Clinical Nutrition, 41(4), 810-817, 1985). A number of body fat measuring instruments based on this principle have been proposed (see, for example, USP No. 4,008,721; Japanese Patent Publication No. 5-49050; and Japanese Utility Model Laid-Open No. 3-27050) and a number of "BIM" type body fat measuring instruments are now available in the market.

[0003] Those prior art instruments include two high frequency current application electrodes and two potential difference measurement electrodes required for measuring the living body impedance. One high frequency current application electrode is paired with one potential difference measurement electrode, and a high frequency current application terminal and a potential difference measurement terminal are disposed at the same end. Then they are attached to hands or feet of a human body. In order to produce a body composition, impedance values measured between a hand and a foot, between both feet or between both hands are basically utilized to derive a whole body composition. Therefore, in the past, the body composition is not necessarily produced by taking into account of a living impedance data in a whole body.

[0004] If it is necessary to change the parts to be measured for getting more precision in measurement, it is frequently difficult to remove and re-attach the electrodes because of paired connection of the high frequency current application electrodes and the potential difference measuring electrodes. Sometime, it is even necessary to take off one's clothes depending on the parts to be measured.

[0005] The prior art four-electrode measuring process can only measure the living body impedance between both feet or between both hands. Accordingly, it is difficult to measure the living body impedance a part by a part of the body.

[0006] Therefore, in case where the living body impedance should be measured a part by a part of the body, it is necessary for a skilled parson to attach four or more electrodes to the relevant parts of the body. In addition, the voltage value measured should be converted into the data such as the impedance on the parts or the body compositions by using highly complicated calculation process. This involves highly expert knowledge and complicated arithmetic operations.

[0007] Another approach has been attempted using four pairs of electrodes each mounted for each of both hands and both feet. The electrodes are switched to perform measurement between different parts of the body. For example, the measurement may be performed between both hands, both feet, the right hand and the right foot, the right hand and the left foot the left hand and the left foot or the left hand and the right foot (see Japanese Patent Laid-Open No. 9-285455).

[0008] However, such approach is defective in that the data required for calculating the values on the parts to be measured involves many unnecessary components so that the measuring process is highly complicated. In addition, even when it is desired to only measure the main body portion, it is very cumbersome to perform because of four different types of data and the different calculations based on such data required. Furthermore, because of possibility of relatively large error inherently generated in the measurement of living body impedance, an amount of error cumulatively increases in proportion to the number of different data types used. Therefore, such approach involves a higher risk especially when it is used to measure the lower impedance portions such as the main body portion.

[0009] In view of the above, there is a need to mitigate or to eliminate the disadvantages of the prior art devices as above. Therefore, one object of the present invention is to provides an improved measuring system that requires no cumbersome repeated attaching and detaching operations for the electrodes, that permits easy measurement of the impedance on each of different parts of a body, and that can produce precise values of body compositions based on the impedance data measured.

Summary of the Invention:

[0010] According to the present invention, high frequency current application electrodes are brought into contact with both hands, both feet, etc., which are extreme parts of a body in order to apply current to the parts of the body to be measured. Potential difference measurement electrodes are brought into contact with the parts to be measured along the path of the high frequency current. High frequency current application electrodes and potential difference measurement electrodes are selected to select the path of the high frequency current and the path of the potential difference measurement in accordance with the purpose.

[0011] Potential difference is allowed to be appeared only on the parts of a body that are included in the path of high frequency current according to 4-ter-

minal law, and therefore, potential difference in any of sections along the path of high frequency current can be measured. As the result, the path of high frequency current and the potential difference measuring sections along the path can be selected in any combination to measure the impedance on desired parts of the body.

Brief Description of the Drawings:

[0012]

Fig. 1 is a block diagram of a system comprising a living body impedance measuring instrument and a body composition measuring instrument according to one embodiment of the present invention;
Fig. 2 is an equivalent circuit diagram of the living body impedance measuring instrument and the body composition measuring instrument according to one embodiment of the present invention;
Fig. 3 is an equivalent circuit diagram of the living body impedance measuring instrument and the body composition measuring instrument when they are arranged to measure the impedance on both legs of a person;
Fig. 4 is an equivalent circuit diagram of the living body impedance measuring instrument and the body composition measuring instrument when they are arranged to measure the impedance on an abdominal region of a person;
Fig. 5 is an equivalent circuit diagram of the living body impedance measuring instrument and the body composition measuring instrument when they are arranged to measure the impedance on both arms of a person;
Fig. 6 is an equivalent circuit diagram of the living body impedance measuring instrument and the body composition measuring instrument when they are arranged to measure the impedance on a chest portion of a person;
Fig. 7 is a block diagram of a system comprising a living body impedance measuring instrument and a body composition measuring instrument according to another embodiment of the present invention;
Fig. 8 is a block diagram of a system comprising a living body impedance measuring instrument and a body composition measuring instrument according to further embodiment of the present invention;
Fig. 9 is a block diagram of a system comprising a living body impedance measuring instrument and a body composition measuring instrument according to yet further embodiment of the present invention; and
Fig. 10 is a flow chart showing the operations of the system according to the present invention.

Description of the Preferred Embodiments:

[0013] Referring now to Fig. 1, one embodiment of the present invention is shown in a block diagram. A body composition measuring instrument as shown in the figure comprises total ten electrodes. More particularly one high frequency current application electrode and one potential difference measurement electrode are mounted on each of both hands and both feet which are extreme parts of a body. In addition, one potential difference measurement electrode is mounted on each of the roots of both arms.

[0014] In the figure, reference numerals 1, 2, 3 and 4 represent the high frequency current application electrodes for applying high frequency current to the body. Those electrodes 1, 2, 3 and 4 are connected to switching means 20 and 21 which are then connected to output terminals of a high frequency current source 30. Electrodes 5, 6, 7, 8, 9 and 10 are connected to switching means 21, 22 and 23. The switching means 22 and 23 are connected to a potential difference measuring device 40, and the switching means 21 is connected to output terminals of the high frequency current source 30. The electrodes 5, 6, 7, 8, 9 and 10 are used for measurement of potential difference, but they may also act as the high frequency current application electrodes for applying high frequency current to the body.

[0015] The switching means 20, 21, 22 and 23 are connected to a control, arithmetic and storage device 50 so that they can independently operate to switch the electrodes according to control signals from the device 50.

[0016] The high frequency current source 30 connected to the switching means 20 and 21 comprises a current detection means for detecting its output current and a frequency change means for changing the frequency of high frequency current, both means are connected to the control, arithmetic and storage device 50. The current detection means functions to inform the detection result to the arithmetic and storage device 50, and the frequency change means functions to change the frequency of high frequency current according to the control signals from the control, arithmetic and storage device 50.

[0017] The switching means 22 and 23 are connected to the potential difference measuring device 40 whose output is connected to the control, arithmetic and storage device 50 via an A/D converter 41. The A/D converter 41 functions to convert the output of the potential difference measuring device 40 into digital values which are then fed to the control, arithmetic and storage device 50.

[0018] An input device 52 is connected to the control, arithmetic and storage device 50 for entering some instructions for operations of the system and parameters for a person to be tested such as height and weight of the person.

[0019] A display device 53 connected to the control, arithmetic and storage device 50 functions to display parameter settings for the person to be tested, measurement results, and some indications indicating when

an error occurs. A buzzer 54 is activated to generate a tone at the time when the measurement is started, the measurement is completed, and any error occurs. A printer 55 produces a hard copy of the measurement results.

[0020] A communication device 56 is connected to the control, arithmetic and storage device 50 in order to communicate between the system and the external devices. The communication device 56 functions to transmit the measurement results to the external devices, while it receives the parameters for the person to be tested and the instructions for operation of the system from the external devices.

[0021] In the embodiment as shown, a memory card is used for the removable storage medium. The parameters used for the measurement and the data such as the measurement results are stored in the memory card through the control, arithmetic and storage device 50.

[0022] The control, arithmetic and storage device 50 functions to selectively activate the switching means 20, 21, 22 and 23 and to control changing of the frequency of the high frequency current. In addition, the device 50 functions to perform an arithmetic operation, based on the data or parameters for the person to be tested (which are entered from the input device, the communication device and the memory card), as well as on the data obtained by the measurement. As the result, the device 50 produces the values of impedance and the body composition, which are then fed to the output devices, the communication device and the memory card.

[0023] A sequence of measuring steps and details of measurement in this embodiment will be described below (with reference to Fig. 10 that shows the flow of the measurement steps). In this embodiment, in order to prevent excessive current from passing through the body due to any defect of the device, before attaching the electrodes to the body, the same electrode is selected by the switching means 20 and 21. This is for the purpose of self-diagnosis for finding out whether the output current is at normal level or at abnormal level. If it is found that the output current is at abnormal level, the measurement is stopped with an indication on the display device that indicates some abnormal condition prevailing in the system.

[0024] If the self-diagnosis is successfully done, the parameters for the person to be tested and the instructions for operations of the system are entered by the input device 52. Then, the electrodes are attached to both hands, both feet and the roots of both arms.

[0025] Before starting the measurement process, in order to examine the contact condition of each electrode, any two different electrodes are selected by the switching means 20 and 21, and the check is made to see if the current passing therebetween is at normal level or not. If an abnormal current passes, it means that any one of or both of the electrodes selected is in poor contact or no contact condition.

[0026] More particularly, while the electrode 1 is kept selected by the switching means 20, one of the electrodes 2 to 10 is sequentially selected by the switching means 21 for examination. If it is found that an abnormal current passes when the electrodes 5 and 10 are selected, it means that the electrodes 5 and 10 are in poor contact or no contact condition. It may happen that all the electrodes 2 to 10 are found abnormal after they are sequentially selected by the switching means 21. In such case, the electrodes 2 is kept selected by the switching means 20 and any one of the electrodes 3 to 10 is sequentially selected by the switching means 21. In such manner, any poor contact or no contact condition of the electrodes can be detected.

[0027] Because of all the electrodes arranged to apply current to the body, the examination of the electrode contact condition can be performed depending on whether the current passing to the body from the high frequency current source is at normal level, or within the normal range, or at abnormal level. This greatly reduces the time period required for the examination. In view of such examination made before starting the measurement, it is unlikely that the measurement process would inevitably be interrupted in the course of measurement due to any defective contact of the electrodes.

[0028] If any abnormal is found out in the examination of electrode contact condition, the buzzer device may sound and/or the display device may display which electrode (or electrodes) is in poor contact or no contact condition, or which electrode is becoming to such condition.

[0029] If no abnormal is found in the examination of electrode contact condition, then the measurement is started.

[0030] For the purpose of describing the present invention, some terms used herein are defined. Referring to Fig. 2 that is the equivalent circuit diagram of the human body, "Z1" and "Z2" mean the impedance of arms; "Z3" and "Z4" mean the impedance of the chest portion; "Z5" means the impedance of the abdominal region; and "Z6" and "Z7" mean the impedance of legs. The electrodes 1 and 5 are attached to and brought into contact with the right hand. Similarly, the electrodes 2 and 6 are attached to the left hand. The electrodes 3 and 7 are attached to the right foot. The electrodes 4 and 8 are attached to the left foot. Finally, the electrode 9 is attached to the root of the right arm, and the electrode 10 is attached to the root of the left arm. Then, the impedance "Z1" is called a "right arm impedance"; "Z2" a "left arm impedance"; "Z3" a "right chest impedance"; "Z4" a "left chest impedance"; "Z5" a "abdominal impedance"; "Z6" a "right leg impedance"; and "Z7" a "left leg impedance".

[0031] The seven impedance "Z1" to "Z7" as indicated in the equivalent circuit of a human body are then measured according to the present invention, as described below.

[0032] When measuring the right leg impedance Z6, the electrode 1 is selected by the switching means 20, the electrode 3 is selected by the switching means 21, the electrode 8 is selected by the switching means 22, and the electrode 7 is selected by the switching means 23. Then, as shown in Fig. 3, the high frequency current I flows through the impedance Z1, Z3, Z5 and Z6 between the electrodes 1 and 3, but it does not flow through the impedance Z7. Therefore, potential difference as measured between the electrodes 7 and 8 is represented by the following formula:

$$\text{Potential Difference } V = Z6 \cdot I$$

Then, the right leg impedance Z6 can be derived.

[0033] Similarly, when measuring the left leg impedance Z7, the electrode 2 is selected by the switching means 20, the electrode 4 is selected by the switching means 21, the electrode 7 is selected by the switching means 22, and the electrode 8 is selected by the switching means 23. Then, the high frequency current I flows through the impedance Z2, Z4, Z5 and Z7 between the electrodes 2 and 4, but it does not flow through the impedance Z6. Therefore, potential difference as measured between the electrodes 7 and 8 is represented by the following formula:

$$\text{Potential Difference } V = Z7 \cdot I$$

Then, the left leg impedance Z7 can be derived.

[0034] When measuring the abdominal impedance Z5, the electrode 1 is selected by the switching means 20, the electrode 3 is selected by the switching means 21, the electrode 6 is selected by the switching means 22, and the electrode 8 is selected by the switching means 23. Then, as shown in Fig. 4, the high frequency current I flows through the impedance Z1, Z3, Z5 and Z6 between the electrodes 1 and 3, but it does not flow through the impedance Z2, Z4 and Z7. Therefore, potential difference as measured between the electrodes 6 and 8 is represented by the following formula:

$$\text{Potential Difference } V = Z5 \cdot I$$

Then, the abdominal impedance Z5 can be derived.

[0035] When measuring the right arm impedance Z1, the electrode 1 is selected by the switching means 20, the electrode 3 is selected by the switching means 21, the electrode 5 is selected by the switching means 22, and the electrode 9 is selected by the switching means 23. Then, as shown in Fig. 5, the high frequency current I flows through the impedance Z1, Z3, Z5 and Z6 between the electrodes 1 and 3. Therefore, potential difference as measured between the electrodes 5 and 9 is represented by the following formula:

$$\text{Potential Difference } V = Z1 \cdot I$$

Then, the right arm impedance Z1 can be derived.

[0036] Similarly, when measuring the left arm impedance Z2, the electrode 2 is selected by the switching means 20, the electrode 4 is selected by the switching means 21, the electrode 6 is selected by the switching means 22, and the electrode 10 is selected by the switching means 23. Then, the high frequency current I flows through the impedance Z2, Z4, Z5 and Z7 between the electrodes 2 and 4. Therefore, potential difference as measured between the electrodes 6 and 10 is represented by the following formula:

$$\text{Potential Difference } V = Z2 \cdot I$$

Then, the left arm impedance Z2 can be derived.

[0037] When measuring the right chest impedance Z3, the electrode 1 is selected by the switching means 20, the electrode 3 is selected by the switching means 21, the electrode 9 is selected by the switching means 22, and the electrode 10 is selected by the switching means 23. Then, as shown in Fig. 6, the high frequency current I flows though the impedance Z1, Z3, Z5 and Z6 between the electrodes 1 and 3, but it does not flow through the impedance Z4. Therefore, potential difference as measured between the electrodes 9 and 10 is represented by the following formula:

$$\text{Potential Difference } V = Z3 \cdot I$$

Then, the right chest impedance Z3 can be derived.

[0038] Similarly, when measuring the left chest impedance Z4, the electrode 2 is selected by the switching means 20, the electrode 4 is selected by the switching means 21, the electrode 10 is selected by the switching means 22, and the electrode 9 is selected by the switching means 23. Then, the high frequency current I flows through the impedance Z2, Z4, Z5 and Z7 between the electrodes 2 and 4, but it does not flow through the impedance Z3. Therefore, potential difference as measured between the electrodes 9 and 10 is represented by the following formula:

$$\text{Potential Difference } V = Z4 \cdot I$$

Then, the left chest impedance Z4 can be derived.

[0039] As described above, the impedance on each of the parts of the body as shown in Fig. 2 are measured in accordance with 4-terminal law. The measurement results are transmitted to the control, arithmetic and storage device 50. On the other hand, the data such as the parameters of the person to be tested are entered and stored in the control, arithmetic and storage device 50 by using the input device in advance. The control, arithmetic and storage device 50 performs the arithmetic operations based on the measurement results and the parameter data to produce the body composition in part of or in whole of the body as well as the distribution for each of the composition components. As the result,

the difference in right-to-left of the arms, chest portions and legs can be derived and they are output to the display device for indication.

[0040] In addition, the impedance measurement is performed again, but with the change in frequency of the high frequency current, and "Cole-Cole plot law" is applied to the measurement results. Then, the amount of intracellular or extracellular fluid as well as the water content in each of the parts of the body can be derived. The measurement results and the parameters of a persons to be tested can partly or wholly be output to the printer device for printing, or transmitted to the external devices via the communication device, or stored in the memory card, depending on the applications, under the control of the control, arithmetic and storage device 50.

[0041] One embodiment of the present invention has been described above. However, depending on the selection of the electrodes used for the measurement, the measurement of only living impedance between both hands, between both feet, or between a hand and a foot can, of course, be done, as in the case of the prior art.

[0042] Apart from the embodiment as above wherein all the parts of the body are measured, only some of the parts, for example, the upper half of the body including both arms and chest portions, may be measured. In such case, the difference in composition for right and left arms and chest portions can be determined from the measurement results.

[0043] Forgoing is the description of the embodiment wherein the impedance on all the parts of the body are measured. Referring to Fig. 8, another embodiment of the present invention is shown in which two high frequency current application electrodes are each attached to the right hand and the right foot, and four potential difference measurement electrodes are each attached to both hands and both foot. According to this embodiment, each of the impedance "Z1 + Z3", "Z5" and "Z6" can be determined in one measurement operation simply by changing the measurement path. Although not shown in the figure, another arrangement is possible wherein two high frequency current application electrodes are each attached to both hands, and four potential difference measurement electrodes are each attached to both hands and to the roots of both arms. In such case, the impedance "Z1" and "Z2" can be determined by changing the potential difference measurement path.

[0044] Referring to Fig. 7, further embodiment of the present invention is shown in which two potential difference measurement electrodes are each attached to the right hand and the right foot, and four high frequency current application electrodes are each attached to both hands and both feet. According to such embodiment, each of the impedance "Z1+Z3", "Z5" and "Z6" can be determined in one measurement operation simply by changing the current application path. Referring to Fig. 9, yet further embodiment of the present invention is shown in which a pair of the high frequency current application electrode and the potential difference measurement electrode is attached to both hands and both feet, respectively. According to such embodiment, each of the impedance "Z1+Z3", "Z2+Z4", "Z5", "Z6" and"Z7" for all the parts of the body can be determined in one measurement operation by independently changing the current application path and the potential difference measurement path.

[0045] It is apparent from the foregoing that the living impedance on each of the parts of a human body can easily be measured so that calculation and assessment of the body composition on each of the parts can be performed. Therefore, the whole body composition derived from such results is contributed by the living impedance information in whole body, thereby improving the accuracy in measurement for the whole body composition.

[0046] If it is desired that the composition on only a part of the body is known, the measurement on only that part of the body can be done. It takes shorter time period and relieves the discomfort of a person to be tested.

[0047] In case where a person was injured on one arm and was subjected to treatment for longer period of time, it is effective to use the composition on the normal arm as the criteria of decision for restoration. In such case, only the part of the body that the person wants to know can be measured within shorter period of time, which relieves the discomfort of the injured person.

[0048] Furthermore, the information indicating the parts of the body to be measured and the changing sequence of the electrodes required for the measurement may be entered to the system in advance as the measurement parameters. In such case, any specified part of the body can be measured simply by selecting any one of the parameters without any complicated operation. Such measurement and operation can easily be done by everybody or unskilled person.

Claims

1. A living body impedance measuring instrument using 4-terminal law, characterized in that it comprises:

   a high frequency current generation source;
   three or more high frequency current application electrodes for applying the high frequency current to the living body;
   a switching means for enabling application of the current along the different current paths to said high frequency current application electrodes;
   a potential difference measuring device; two potential difference measurement electrodes for measuring the potential difference;
   a control and arithmetic device;

a storage device; and
an output means;
whereby said current path switching means is connected to such high frequency current application electrodes that allows measurement of an impedance on the target part of the body under the control of said control and arithmetic device;
a voltage value obtained from said potential difference measuring device is converted into the impedance value of said target part in said arithmetic device;
said impedance value is stored in said storage device; and
said impedance value is output to said output means.

2. A living body impedance measuring instrument using 4-terminal law, characterized in that it comprises:

a high frequency current generation source;
two high frequency current application electrodes for applying the high frequency current to the living body;
a potential difference measuring device;
three or more potential difference measurement electrodes for measuring the potential difference;
a switching means for enabling measurement of the potential difference on the different parts of the body by said potential difference measurement electrodes;
a control and arithmetic device; and
an output means;
whereby the high frequency current is applied to the living body via said two high frequency current application electrodes;
said switching means is connected to such potential difference measurement electrodes that can measure potential difference on the target part of the body under the control of said control and arithmetic device;
a voltage value obtained from said potential difference measuring device is converted into the impedance value of said target part in said arithmetic device;
said impedance value is stored in a storage device; and
said impedance value is output to said output means.

3. A living body impedance measuring instrument using 4-terminal law, characterized in that it comprises:

a high frequency current generation source;
three or more high frequency current application electrodes for applying the high frequency current to the living body;
a first switching means for enabling application of the current along the different current paths to said high frequency current application electrodes;
a potential difference measuring device;
three or more potential difference measurement electrodes for measuring the potential difference;
a second switching means for enabling measurement of the potential difference on the different parts of the body by said potential difference measurement electrodes;
a control and arithmetic device; and
an output means;
whereby the high frequency current application electrodes and the potential difference measurement electrodes are independently switched in such combination that the potential difference on the target part of the body can be measured under the control of said control device;
a voltage value obtained from said potential difference measuring device is converted into the impedance value of said target part in said arithmetic device;
said impedance value is stored in a storage device; and
said impedance value is output to said output means.

4. A living body impedance measuring instrument using 4-terminal law, characterized in that it comprises:

four or more electrodes;
a high frequency current generation source;
a potential difference measuring device;
a switching means for selectively connecting said high frequency current generation source or the potential difference measuring device to each of said four or more electrodes;
a control and arithmetic device; and
an output means;
whereby the high frequency current application electrodes and the potential difference measurement electrodes are independently switched in such combination that the potential difference on the target part of the body can be measured under the control of said control device;
a voltage value obtained from said potential difference measuring device is converted into the impedance value of said target part in said arithmetic device;
said impedance value is stored in a storage device; and

said impedance value is output to said output means.

5. A living body impedance measuring instrument according to any one of Claims 1 to 4 wherein it further comprises an input means; and

said control device instructs to switch the high frequency application electrodes and the potential difference measurement electrodes depending on the input information for measuring only the required part of the body;
said arithmetic device operates to convert a voltage value obtained into the impedance value of said required part of the body;
said impedance value is stored in a storage device; and
said impedance value is output to said output means.

6. A living body impedance measuring instrument according to Claims 3 and 5 wherein it comprises:

four high frequency current application electrodes each brought into contact with each of both hands and both feet which are extreme parts of the body; and
four potential difference measurement electrodes each brought into contact with each of both hands and both feet which are extreme parts of the body and each along the path of the high frequency current applied by said high frequency current application electrodes.

7. A living body impedance measuring instrument according to Claims 3 and 5 wherein it comprises:

four high frequency current application electrodes each brought into contact with each of both hands and both feet which are extreme parts of the body;
four potential difference measurement electrodes each brought into contact with each of both hands and both feet which are extreme parts of the body and each along the path of the high frequency current applied by said high frequency current application electrodes; and
two additional potential difference measurement electrodes each brought into contact with each of the roots of both arms.

8. A living body impedance measuring instrument according to Claims 2 and 5 wherein it comprises:

two high frequency current application electrodes each brought into contact with each of both hands which are extreme parts of the body;
two potential difference measurement electrodes each brought into contact with each of both hands which are extreme parts of the body and each along the path of the high frequency current applied by said high frequency current application electrodes; and
two additional potential difference measurement electrodes each brought into contact with each of the roots of both arms.

9. A body composition measuring instrument in combination with a living body impedance measuring instrument according to Claims 1 to 8 wherein it produces a body composition in a whole body, a body composition in a part of the body, or both of them, based upon the living body impedance as derived from said living body impedance measuring instrument, and upon the physical characteristics of a person to be tested such as height, weight, etc. of the person.

10. A body composition measuring instrument in combination with a living body impedance measuring instrument according to Claims 1 to 8 wherein it produces a body composition in a whole body, a body composition in a part of the body, or both of them, based upon the living body impedance as derived from said living body impedance measuring instrument, and upon the physical characteristics of a part to be measured such as length, diameter, etc.

11. A living body impedance measuring instrument according to Claims 1 to 8 wherein the parts of the body to be measured and the voltage measurements are stored in the storage device with mutually corresponding relationship, and calculation of the impedance is performed with a formula corresponding to each of the parts to be measured.

12. A body composition measuring instrument according to Claims 9 and 10 wherein the parts of the body to be measured and the voltage measurements are stored in the storage device with mutually corresponding relationship, and calculation of the impedance is performed with a formula corresponding to each of the parts to be measured.

13. A living body impedance measuring instrument according to Claims 1 to 8 wherein it comprises a removable recording medium; and wherein said control device instructs to store the data derived by the measurement and arithmetic operation to said recording medium.

14. A body composition measuring instrument according to Claims 9 and 10 wherein it comprises a removable recording medium; and wherein said

control device instructs to store the data derived by the measurement and arithmetic operation to said recording medium.

15. A living body impedance measuring instrument according to Claims 1 to 8 wherein it comprises a communication device for communication with the outside of the instrument; and wherein said control device instructs to output the data derived by the measurement and arithmetic operation via the communication device.

16. A body composition measuring instrument according to Claims 9 and 10 wherein it comprises a communication device for communication with the outside of the instrument; and wherein said control device instructs to output the data derived by the measurement and arithmetic operation via the communication device.

17. A living body impedance measuring instrument according to Claims 1 to 8 wherein it comprises a communication device for communication with the outside of the instrument; and wherein said control device instructs to input the data required for the arithmetic operation via the communication device.

18. A body composition measuring instrument according to Claims 9 and 10 wherein it comprises a communication device for communication with the outside of the instrument; and wherein said control device instructs to input the data required for the arithmetic operation via the communication device.

19. A living body impedance measuring instrument according to Claims 1 to 8 wherein it operates to change the frequency of the high frequency current according to a control signal from the control device and to apply it to the living body.

20. A body composition measuring instrument according to Claims 9 and 10 wherein it operates to change the frequency of the high frequency current according to a control signal from the control device and to apply it to the living body.

21. A living body impedance measuring instrument according to Claims 1 to 8 wherein the measurement is performed, based upon the information about the parts to be measured or measurement parameters that are already stored and upon the electrode switching information for selecting the electrodes; or alternatively the measurement is performed, based upon a measurement parameter which is selected among a plurality of the measurement parameters already stored.

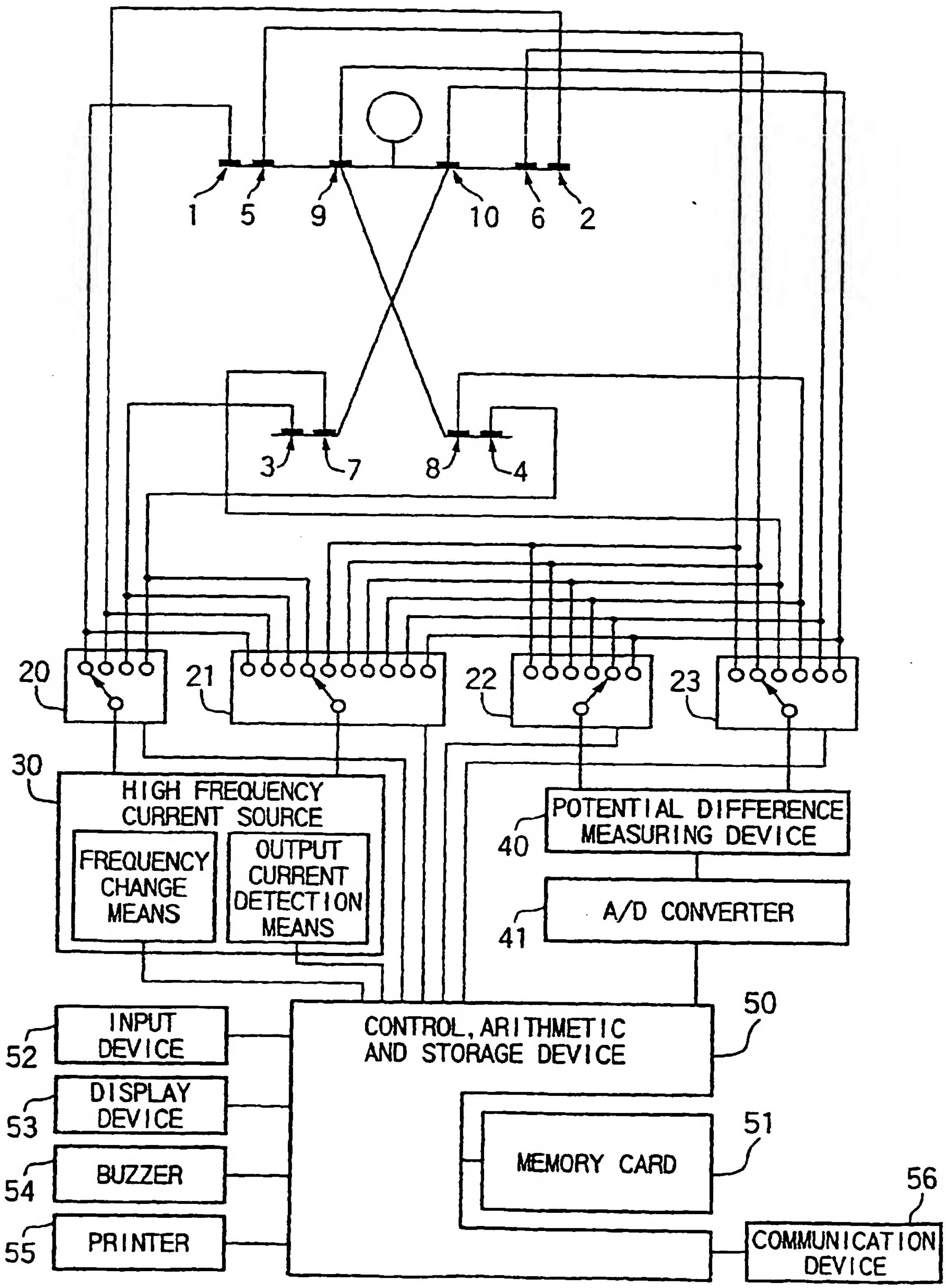
22. A body composition measuring instrument according to Claims 9 and 10 wherein the measurement is performed, based upon the information about the parts to be measured or measurement parameters that are already stored and upon the electrode switching information for selecting the electrodes; or alternatively the measurement is performed, based upon a measurement parameter which is selected among a plurality of the measurement parameters already stored.

23. A combination of a living body impedance measuring instrument and a body composition measuring instrument, characterized in that it comprises:

a detection means for detecting whether an electrode is in contact with the living body or not; and

a control device for acting in such manner that when it is found that there is no contact present between the electrode and the living body it outputs no data produced by a measurement and arithmetic operation to an output device or it informs the output device that there is no contact present between the electrode and the living body.

FIG. 1


1
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9
10
6
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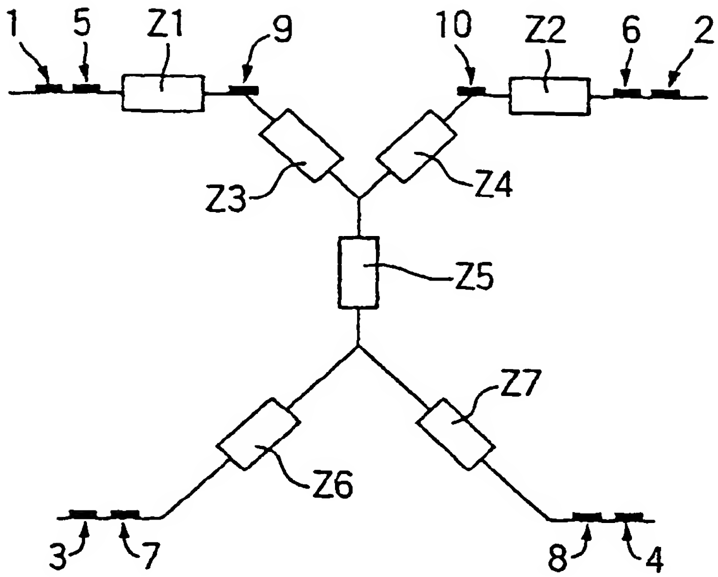
3
7
8
4
20
21
22
23
30
HIGH FREQUENCY CURRENT SOURCE
FREQUENCY CHANGE MEANS
OUTPUT CURRENT DETECTION MEANS
40
POTENTIAL DIFFERENCE MEASURING DEVICE
41
A/D CONVERTER
50
CONTROL, ARITHMETIC AND STORAGE DEVICE
51
MEMORY CARD
52
INPUT DEVICE
53
DISPLAY DEVICE
54
BUZZER
55
PRINTER
56
COMMUNICATION DEVICE

FIG. 2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Z1
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Z2
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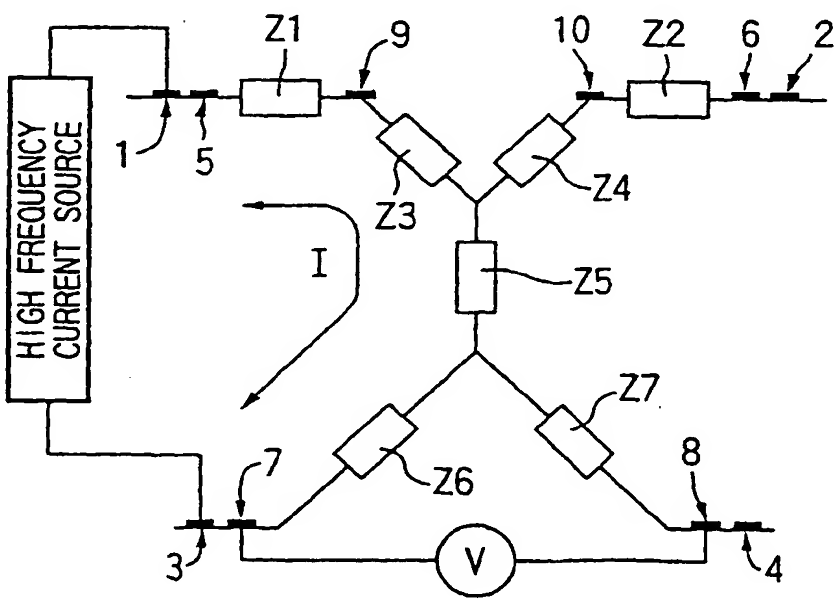
Z3
Z4
Z5
Z7
Z6
3
7
8
4

FIG. 3


HIGH FREQUENCY CURRENT SOURCE
Z1
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10
Z2
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1
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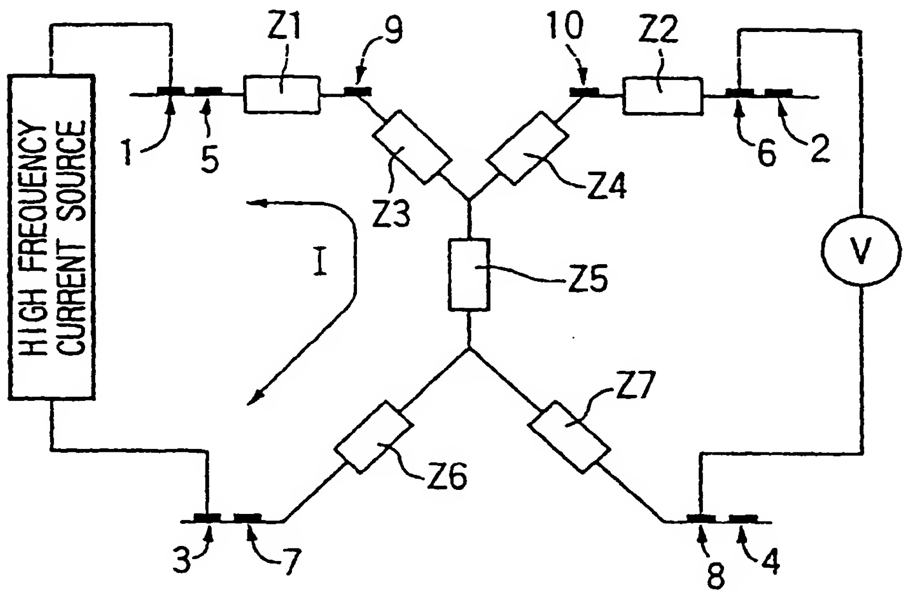
Z3
Z4
I
Z5
Z7
8
7
Z6
3
V
4

FIG. 4


HIGH FREQUENCY CURRENT SOURCE
Z1
9
10
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Z3
Z4
I
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V
Z7
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FIG. 5

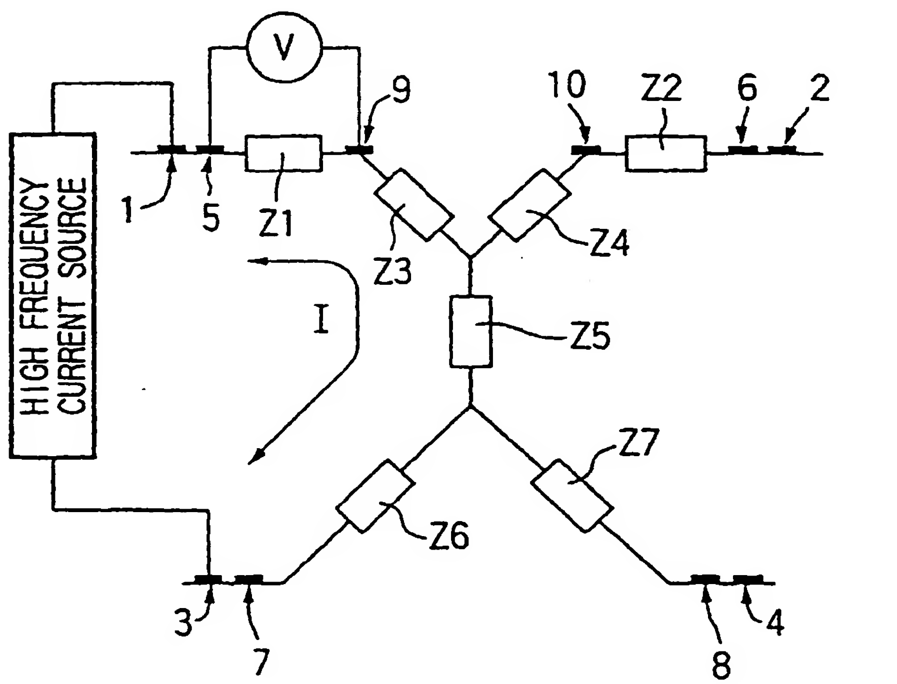

V
9
10
Z2
6
2
HIGH FREQUENCY CURRENT SOURCE
1
5
Z1
Z3
Z4
I
Z5
Z7
Z6
3
7
8
4

FIG. 6

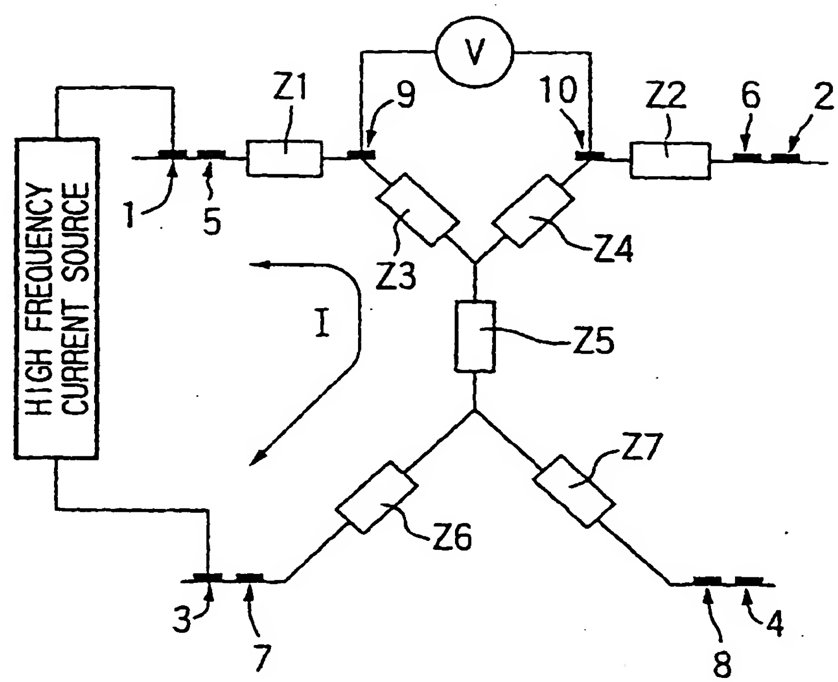
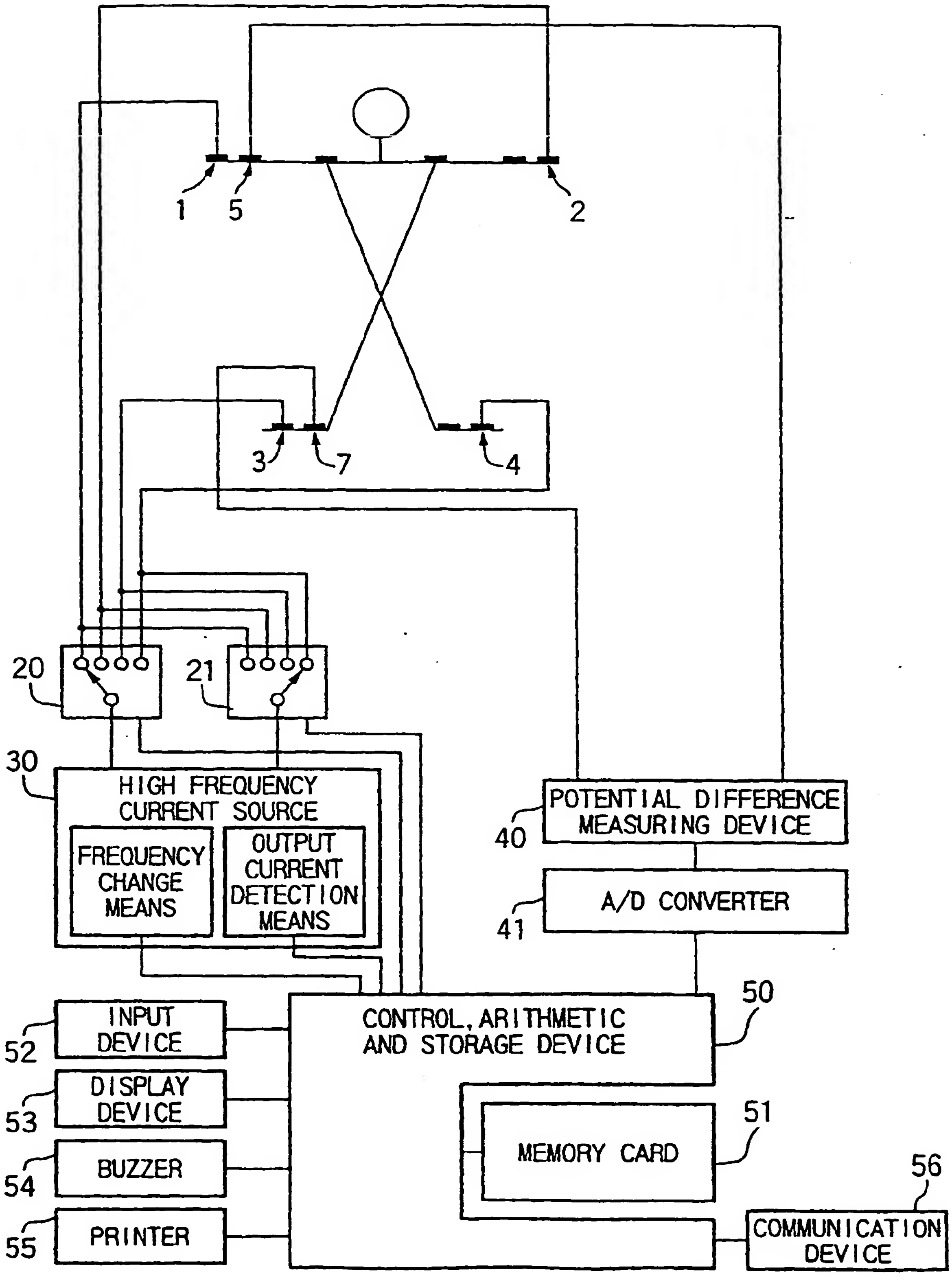

V
Z1
9
10
Z2
6
2
HIGH FREQUENCY CURRENT SOURCE
1
5
Z3
Z4
I
Z5
Z7
Z6
3
7
8
4

FIG. 7


1
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HIGH FREQUENCY CURRENT SOURCE
FREQUENCY CHANGE MEANS
OUTPUT CURRENT DETECTION MEANS
40
POTENTIAL DIFFERENCE MEASURING DEVICE
41
A/D CONVERTER
50
CONTROL, ARITHMETIC AND STORAGE DEVICE
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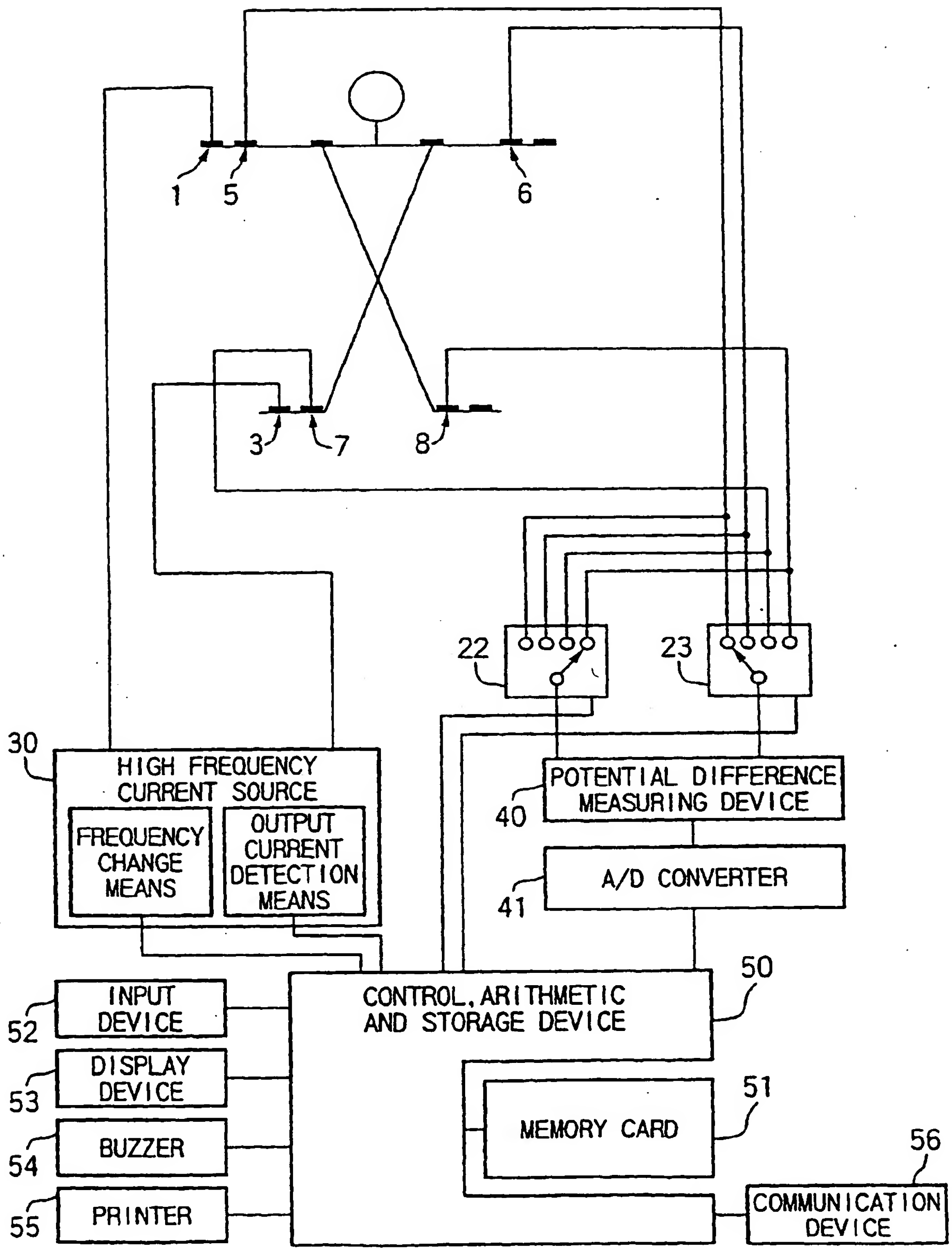
MEMORY CARD
52
INPUT DEVICE
53
DISPLAY DEVICE
54
BUZZER
55
PRINTER
56
COMMUNICATION DEVICE

FIG. 8


1
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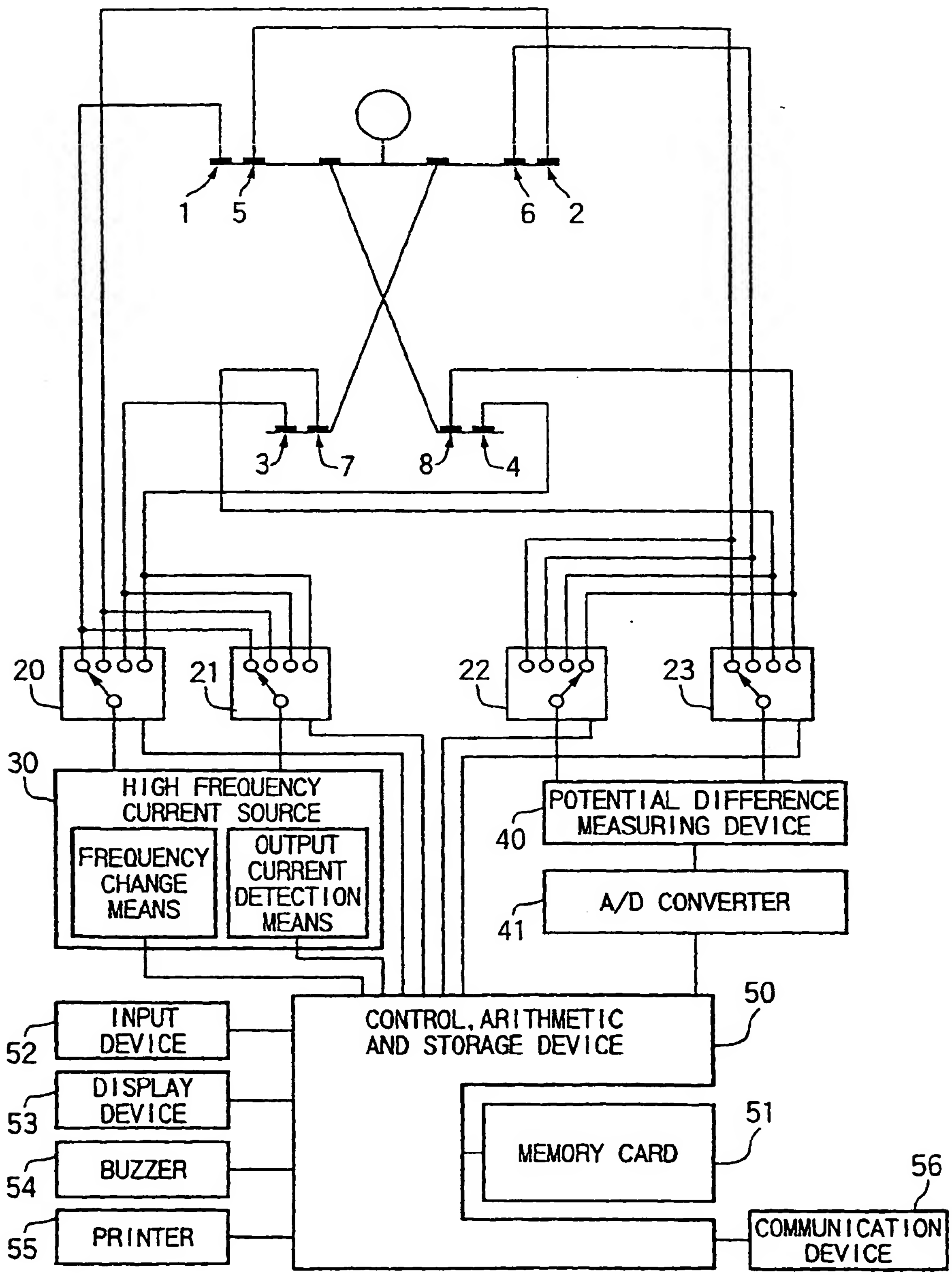
HIGH FREQUENCY CURRENT SOURCE
FREQUENCY CHANGE MEANS
OUTPUT CURRENT DETECTION MEANS
POTENTIAL DIFFERENCE MEASURING DEVICE
40
A/D CONVERTER
41
50
CONTROL, ARITHMETIC AND STORAGE DEVICE
INPUT DEVICE
52
DISPLAY DEVICE
53
BUZZER
54
PRINTER
55
MEMORY CARD
51
56
COMMUNICATION DEVICE

FIG. 9


1
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20
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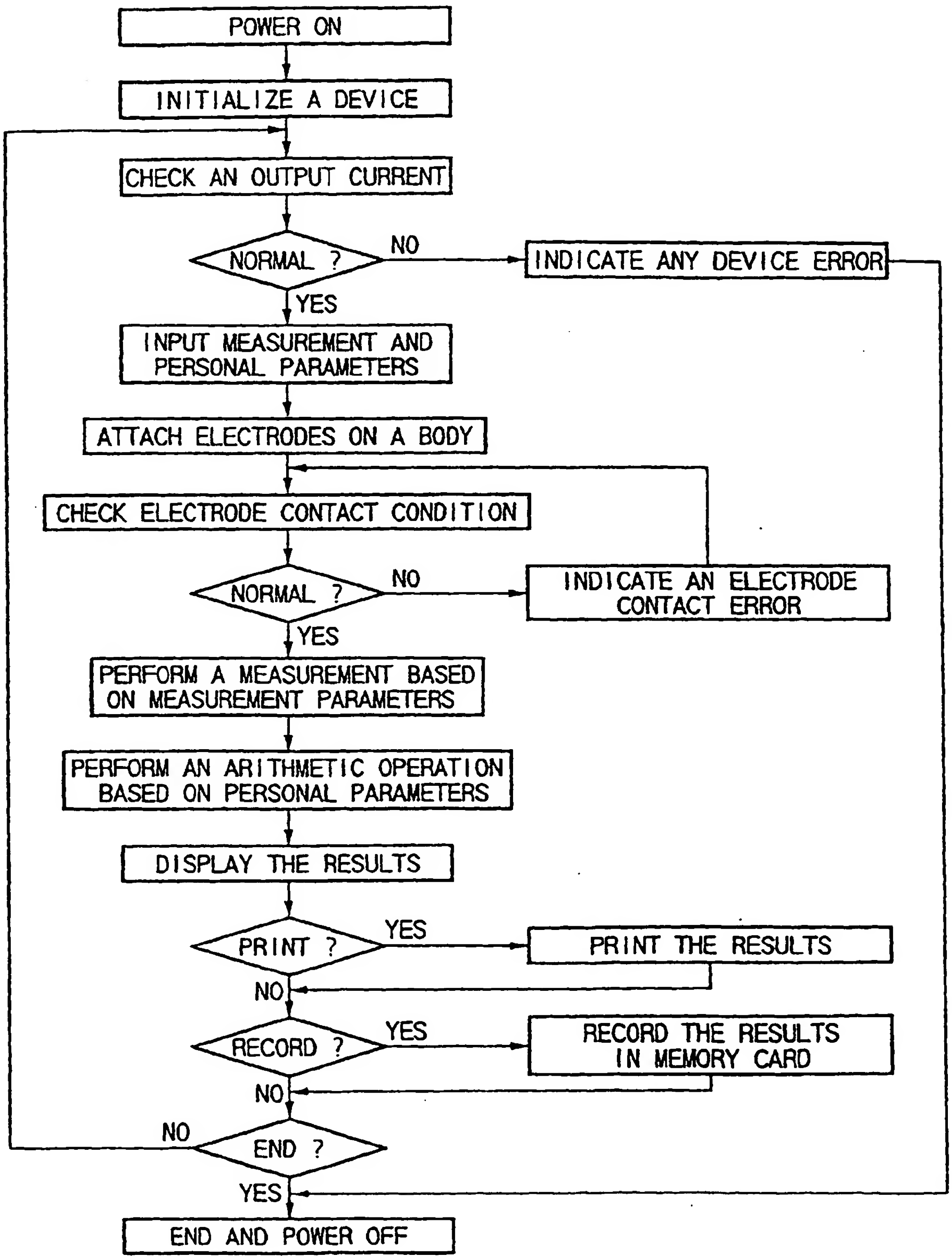
22
23
30
HIGH FREQUENCY CURRENT SOURCE
FREQUENCY CHANGE MEANS
OUTPUT CURRENT DETECTION MEANS
POTENTIAL DIFFERENCE MEASURING DEVICE
40
A/D CONVERTER
41
50
CONTROL, ARITHMETIC AND STORAGE DEVICE
52
INPUT DEVICE
53
DISPLAY DEVICE
54
BUZZER
55
PRINTER
MEMORY CARD
51
56
COMMUNICATION DEVICE

FIG. 10


POWER ON
INITIALIZE A DEVICE
CHECK AN OUTPUT CURRENT
NORMAL ?
NO
INDICATE ANY DEVICE ERROR
YES
INPUT MEASUREMENT AND PERSONAL PARAMETERS
ATTACH ELECTRODES ON A BODY
CHECK ELECTRODE CONTACT CONDITION
NORMAL ?
NO
INDICATE AN ELECTRODE CONTACT ERROR
YES
PERFORM A MEASUREMENT BASED ON MEASUREMENT PARAMETERS
PERFORM AN ARITHMETIC OPERATION BASED ON PERSONAL PARAMETERS
DISPLAY THE RESULTS
PRINT ?
YES
PRINT THE RESULTS
NO
RECORD ?
YES
RECORD THE RESULTS IN MEMORY CARD
NO
NO
END ?
YES
END AND POWER OFF

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/00736

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[6] A61B5/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[6] A61B5/05

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1945-1997 Toroku Jitsuyo Shinan Koho 1994-1997
Kokai Jitsuyo Shinan Koho 1971-1995

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP, 7-79938, A (Omron Corp.), March 28, 1995 (28. 03. 95) (Family: none)	1-22
X	JP, 7-12635, A (YA-MAN Ltd.), January 17, 1995 (17. 01. 95) (Family: none)	1-22
X	JP, 7-79938, A (Omron Corp.), March 28, 1995 (28. 03. 95) (Family: none) Par. No. [0042]	23
X	Microfilm of Japanese Utility Model Application No. 36495/1974 (Laid-open No. 12528/1975) (Tokyo Shibaura Electric Co., Ltd.), October 14, 1975 (14. 10. 75) (Family: none)	23
X	JP, 8-154910, A (Omron Corp.), June 18, 1996 (18. 06. 96) (Family: none)	23

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
April 20, 1998 (20. 04. 98)	April 28, 1998 (28. 04. 98)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)